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Indian Standard

GUIDE FOR DESIGNING DETAIL SPECIFICATIONS OF RADIO-FREQUENCY COAXIAL CABLES

[IEC TITLE : RADIO-FREQUENCY CABLES — PART 0 : GUIDE TO THE DESIGN OF DETAIL SPECIFICATIONS — SECTION 1 — COAXIAL CABLES]

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NEW DELHI 110002

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Wires, Cables, Waveguides and Accessories Sectional Committee, LTD 18

NATIONAL FOREWORD

This Indian Standard which is identical with IEC Pub 96-0-1 (1990) 'Radio-frequency cables — Part 0 : Guide to the design of detail specifications — Section 1 — Coaxial cables' issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on the recommendation of Wires, Cables, Waveguides and Accessories Sectional Committee, LTD 18, and approval of the Electronics and Telecommunication Division Council.

The text of the IEC standard has been approved as suitable for publication as Indian Standard without deviations. Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

CROSS REFERENCES

In this Indian Standard, the following International Standard is referred to. Read in its place the following:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 68-2: Environmental testing, Part 2 : Tests	IS 9000 Basic environmental testing procedures for electronic and electrical items	Technically Equivalent

Only the English language text in the International Standard has been retained while adopting it in this Indian Standard.

Indian Standard

GUIDE FOR DESIGNING DETAIL SPECIFICATIONS OF RADIO-FREQUENCY COAXIAL CABLES

[IEC TITLE : RADIO-FREQUENCY CABLES — PART 0 : GUIDE TO THE DESIGN OF DETAIL SPECIFICATIONS — SECTION 1 — COAXIAL CABLES]

1 Scope

This part of the standard gives recommendations for design parameters, including nominal characteristic impedances and diameter over dielectric, and guidance for the design of radio-frequency coaxial cables with braid, metallic tapes or tubular outer conductors.

2 Register of symbols used

Symbol	Designation	Unit
α	Total attenuation per unit length, 20 °C	dB/m
α_T	Total attenuation per unit length, $T \neq 20$ °C	dB/m
α_x	Attenuation due to element x, 20 °C	dB/m
β_x	Braid angle of element x	° (degree)
γ_x	Density of the material of element x	g/cm^3
δ_x	Loss angle of the material of element x	rad
ε_x	Relative dielectric permittivity of the material of element x	-
χ_x	Conductivity of the material of element x, 20 °C	m/Ωmm^2
σ_x	Thermal resistivity of the material of element x	K·m/W
B_x	Braid coverage concerning element x	-
c_0	Velocity of propagation in free space	m/s
C_x	Capacitance of element x, per unit length	pF/m
d_x	Diameter of individual wires of element x	mm
D_x	Outer diameter of element x	mm
D_{xe}	Electrical effective diameter of element x	mm
D_{xm}	Mean diameter of element x	mm
E_2	Maximum permissible voltage gradient of dielectric (peak value)	kV/mm
f	Frequency	MHz
h_x	Coating thickness concerning element x	mm
k_x, k_{xy}	Calculation factors according to tables 2.1 and 2.2	-
L_x	Braid lay length concerning element x	mm
m	Total weight of cable per unit length	g/m
m_x	Weight of element x	g/m
N_1	Number of stranded wires of inner conductor	-
N_x	Number of wires to each spindle concerning braid x	-
n_x	Number of spindles in the braid concerning element x	-
P_{40}	Maximum permissible input power, ambient temperature 40 °C	W
P_T	Maximum permissible input power, ambient temperature $T \neq 40$ °C	W
P_d	Maximum permissible dissipation power per unit length	W/m
q_x	Filling factor of braid concerning element x	-
R_x	D.C. resistance of conductive element x, per unit length	Ω/m
	and insulation resistance of insulating element x respectively	MΩ km
s_x	Nominal thickness of element x	mm
$s_{x\min.}$	Minimal thickness of element x	mm
T_x	Temperature of element x	°C
T_a	Ambient temperature	°C
U_t	Test voltage (50 Hz), rounded r.m.s. value	kV
U_{tc}	Test voltage (50 Hz), calculated r.m.s. value	kV
U_d	Discharge test voltage, r.m.s. value	kV
U_0	Maximum permissible operating voltage, rounded r.m.s. value	kV
U_{0c}	Maximum permissible operating voltage, calculated r.m.s. value	kV
v_r	Velocity ratio	-
z_0	Characteristic impedance, nominal value	Ω

Numbering of construction elements:

1. Inner conductor
2. Dielectric
3. Outer conductor
4. Sheath
5. Medium between outer conductor and screen
6. Screen
7. Medium between first and second screen
8. Second screen

etc.

Table 2.1 — Example of use of k_x factor

Symbol	Designation	Unit
k_2	Factor dependent on inner conductor concerning the voltage gradient in the dielectric	-
k_4	Thermal dissipation constant of sheath surface in air	$W/m^2K^{1.25}$

Table 2.2 — Example of use of k_{xy} factor

Factor	Construction element concerned			
	1	3	6	8
Coating factor	k_{1c}	k_{3c}		
Stranding or braiding factor:				
— concerning attenuation	k_{1a}	k_{3a}		
— concerning d.c. resistance and weight	k_{1r}	k_{3r}	k_{6r}	k_{8r}
Ratio between overall diameter and diameter of individual wires	k_{1d}			
Effective diameter factor concerning characteristic impedance	k_{1z}			

3 Material constants

3.1 *Table of material constants relating to dielectric and sheath and their values for different materials*

Table 3.1

Symbol	Designation	Unit	Value for 1)								
			Solid PE	Cellular 2) PE			PTFE	FEP	ETFE	PFA	PVC
ε_2	Permittivity of dielectric	-	2.28	1.3	1.5	1.7	2.1	2.1	2.6	2.1	
tan δ_2	Dissipation factor of dielectric	-	$2.5 \cdot 10^{-4}$	$4 \cdot 10^{-4}$	$6 \cdot 10^{-4}$	$6 \cdot 10^{-4}$	3)	6)	5)	5)	
E_2	Maximum permissible voltage gradient of dielectric	kV/mm	110	20	20	20	110		5)	5)	
γ_2, γ_4	Density of dielectric or sheath	g/cm^3	0.93	0.28	0.44	0.58	2.2	2.2	1.7	2.2	1.4 2)
σ_2, σ_4	Thermal resistivity of dielectric or sheath	K·m/W	3.5	15	9	6	4.4	5.0	4.4	4.5	7.0
T_1	Maximum permissible operating temperature	°C	85/80 4)	70	70	70	250	200 7)	150 7)	200 7)	70

---

1) PE = polyethylene
PTFE = polytetrafluoroethylene
FEP = fluorinated ethylene propylene
ETFE = ethylenetetrafluoroethylene
PFA = perfluoroalcoxylalkane
PVC = polyvinylchloride

2) Typical value(s).

3)

Frequency (MHz)	tan δ_2
1	$1 \cdot 10^{-4}$
10^1	$1.5 \cdot 10^{-4}$
10^2	$2.5 \cdot 10^{-4}$
10^3	$4.3 \cdot 10^{-4}$
10^4	$2 \cdot 10^{-4}$

4) 85 °C: high density material.
80 °C: other density material.

5) Under consideration.

6)

Frequency (MHz)	tan δ_2
1	$4 \cdot 10^{-4}$
10^1	$4 \cdot 10^{-4}$
10^2	$8 \cdot 10^{-4}$
10^3	$10 \cdot 10^{-4}$
$2 \cdot 10^3$	$10 \cdot 10^{-4}$
10^4	$7 \cdot 10^{-4}$

7) In the case of silvered inner and outer conductors only.

3.2 *Tables of material constants relating to conductors*

Table 3.2.1 — Conductivity (at 20 °C) and density

Material	Symbols	Unit	Value	Symbols	Unit	Value
Copper	χ_1, χ_3, χ_6	m/Ωmm^2	58	$\gamma_1, \gamma_3, \gamma_6$	g/cm^3	8.9
Aluminium			35			2.7
Tin			8.3			7.3
Silver			61			10.5
Copper clad steel 30%			17.4[1]			8.15
Copper clad steel 40%			23.2[1]			8.20

[1] For calculation of d.c. resistance only.

Table 3.2.2 — Coating factor[1]

Conductor	Symbol	Value
Bare copper wire	k_{1c} and k_{3c}	1
Silvered copper wire		1
Tinned copper wire		Table 3.2.3
Copper clad steel wire		Table 3.2.4

[1] RF resistance of coated wire in relation to bare copper wire, dependent on frequency and coating thickness

Table 3.2.3 — Tinned copper wire

$h_1\sqrt{f}$ or $h_3\sqrt{f}$	k_{1c} or k_{3c}
0.01	1.01
0.02	1.03
0.03	1.06
0.04	1.11
0.06	1.25
0.08	1.44
0.10	1.67
0.12	1.91
0.15	2.24
0.18	2.46
0.20	2.60
$\geq$0.25	2.70

Table 3.2.4. — Copper clad steel wire

$h_1\sqrt{f}$	k_{1c}[1]
0.005	11.04
0.010	6.06
0.015	4.16
0.020	3.17
0.025	2.57
0.030	2.16
0.035	1.87
0.040	1.65
0.050	1.35
0.060	1.16
0.070	1.04
0.080	1.00

[1] Assumptions relating to steel:
$\chi = 8$ m/Ωmm^2.
Relative permeability, $\mu_r = 200$.

3.3 *Construction constants*

3.3.1 *Table of construction constants relating to inner conductor*

Table 3.3.1

Symbol	Designation	Value versus number of strands (N_1)			
		1	7	12	19
k_{1r}	Stranding factor for d.c. resistance and weight	1.00	1.03	1.03	1.03
k_{1a}	Stranding factor for attenuation	1.00	1.25	1.25	1.25
k_{1z}	Effective diameter factor	1.00	0.94	0.96	0.98
k_{1d}	Ratio between overall diameter and diameter of individual wires	1.00	3.02	4.16	5.00
k_2	Voltage gradient factor	1.00	0.90	0.90	0.90

3.3.2 *Table of construction constants relating to braided outer conductors and screens*

Table 3.3.2

Braid angle β_3; β_6	$\frac{L_3}{D_{3m}}$; $\frac{L_6}{D_{6m}}$	k_{3r}; k_{6r}
20°	8.63	1.06
25°	6.74	1.10
30°	5.44	1.15
35°	4.49	1.22
40°	3.74	1.30
45°	3.14	1.41

Definitions:

$$k_{3r} = \sqrt{1 + (\pi D_{3m} / L_3)^2} = \frac{1}{\cos \beta_3}$$

$$k_{6r} = \sqrt{1 + (\pi D_{6m} / L_6)^2} = \frac{1}{\cos \beta_6}$$

3.4 *Braid wire dimensions*

Table of braid wire dimensions of outer conductor and screen

Table 3.4

Nominal outer diameter of dielectric (D_2) mm	Nominal diameter of braid wire (d_3, d_6) mm	
	Single braid	Double braid
0.87 and 1.5	0.09-0.11	-
2.95, 3.7, 4.8 and 6.4	0.13-0.15	0.13-0.15
7.25, 9.8 and 11.5	0.18-0.20	0.16-0.18
17.3	0.24-0.26	0.18-0.20

3.5 *Attenuation factors*

Table 3.5 — Factor relating to calculation of attenuation

Symbol	Designation	Feature	Value
k_{1a}	Attenuation due to inner conductor	Solid wire Stranded wire	1.0 1.25
k_{1c}		Tinned copper wires Copper clad steel wire	See table 3.2.3 See table 3.2.4
k_{3a}	Attenuation due to outer conductor	Tubular outer conductor Braided outer conductor	1.0 2.0[1]
k_{3c}		Braid wires tinned copper	See table 3.2.3

[1] Rough approximation (in absence of a reliable theory).

3.6 *Maximum permissible input power*

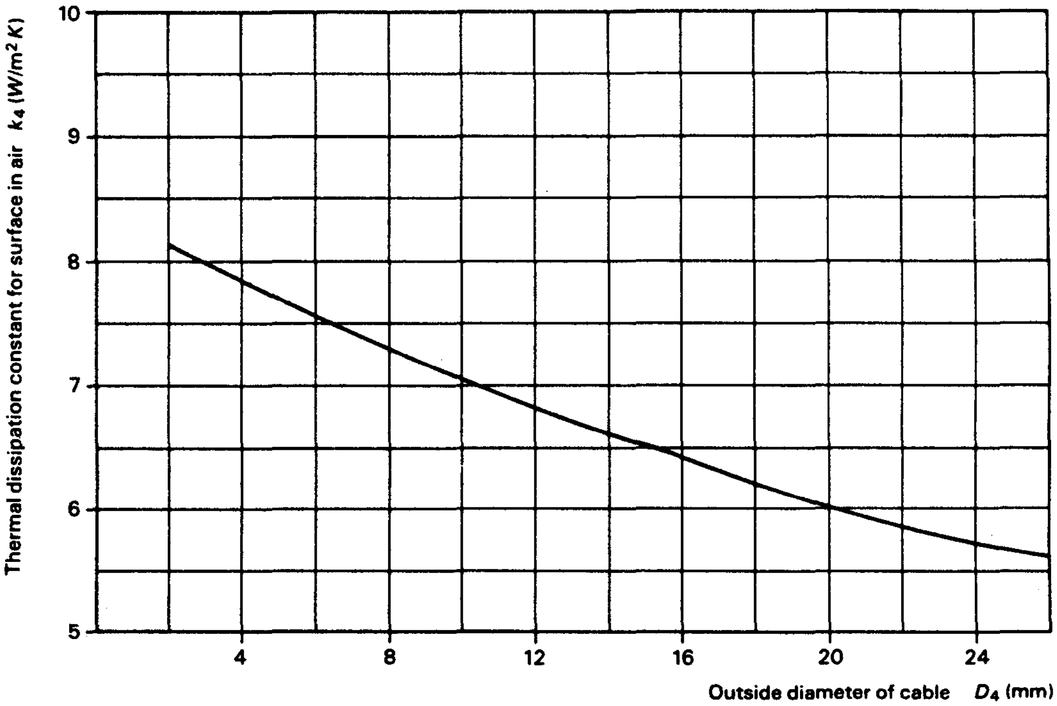

Figure 1 — Graph for calculation of maximum permissible input power

4 Standard values of characteristic impedance and outer diameter of dielectric

4.1 *Nominal characteristic impedance of coaxial cables*

All impedances specified in this clause are defined at a frequency of 200 MHz (Mc/s) and at the reference temperature of 20 °C.

Standard values of nominal characteristic impedance are:

50 Ω

93 Ω

75 Ω

4.2 *Nominal diameters over dielectric of coaxial cables*

Nominal diameters D_2 over dielectric and the tolerances thereon shall be in accordance with the following table:

Table 4

Nominal value	0.87	1.50	2.95	3.70	4.80	6.40	7.25	9.80	11.50	17.30
Tolerance ±	0.07	0.10	0.13	0.15	0.20	0.20	0.25	0.25	0.30	0.40

5 Cable construction details

5.1 *General*

The starting point is to determine:

a) the nominal characteristic impedance, z_0 (according to 4.1);

b) the outer diameter of dielectric, D_2 (according to 4.2);

c) the permittivity of dielectric, ε_2 (table 3.1).

Calculate the effective diameter of outer conductor, D_{3e}.

Table 5.1 — Special design features

Outer conductor	Diameter D_{3e}
Tubular	$D_{3e} = D_2$
Braided	$D_{3e} > D_2$ (see 5.4)

5.2 *Inner conductor*

The electrical effective diameter D_{1e} of the inner conductor follows from:

$$D_{1e} = D_{3e} \exp(-z_0 \sqrt{\varepsilon_2}/60)^{1)}$$

Table 5.2

Special design features	
Solid inner conductor	Diameter D_1 as calculated
Stranded inne- conductor	Diameter $D_1 > D_{1e}$ (see 5.3)

---

[1] Rounded up from 59.96.

5.3 *Stranded inner conductor*

The diameter D_1 is to be calculated from the effective diameter D_{1e}:

$$D_1 = D_{1e}/k_{1z}$$

The wire diameter d_1 is to be calculated from D_1:

$$d_1 = D_1/k_{1d}$$

k_{1d} and k_{1z} according to table 3.3.1.

5.4 *Braided outer conductor*

Table 5.4

The effective diameter D_{3e} outer diameter D_3 mean diameter D_{3m} are to be calculated from the outer diameter of dielectric D_2 and the diameter of the braid wires d_3: $D_{3e} = D_2 + 1.5\,d_3$ $D_3 = D_2 + 4.5\,d_3$ $D_{3m} = D_2 + 2.25\,d_3$ d_3 according to table 3.4
The filling factor of the braid is: $q_3 = \frac{N_3\,n_3\,d_3\,k_{3r}}{2\pi\,D_{3m}}$ d_3 and D_{3m} as above k_{3r} according to table 3.3.2
The coverage and the braid angle of the outer conductor are given by: $B_3 = 2q_3 - q_3^2$ $\beta_3 = \arctan \pi D_{3m}/L_3$

5.5 *Medium between outer conductor and screen*

Table 5.5

The outer diameter of the interposed medium is: $D_5 = D_3 + 2\,s_5$

5.6 *Braided screen*

Table 5.6

The outer diameter D_6 and the mean diameter D_{6m} are to be calculated from the outer diameter of the interposed medium D_5 and the diameter of the braid wires, d_6: $D_6 = D_5 + 4.5\,d_6$ $D_{6m} = D_5 + 2.25\,d_6$ d_6 according to table 3.4
The filling factor of the braid is: $q_6 = \frac{N_6\,n_6\,d_6\,k_{6r}}{2\pi\,D_{6m}}$ d_6 and D_{6m} as above k_{6r} according to table 3.3.2
The coverage and the braid angle of the screen are given by: $B_6 = 2q_6 - q_6^2$ $\beta_6 = \arctan \pi D_{6m}/L_6$

5.7 *Sheath*

Table 5.7

Material	Outer diameter of screen, D_6[1]	Nominal thickness s_4	Minimum thickness s_4 min.
FEP	<2.5	0.25 mm	0.15 mm
PTFE	2.5-5.9	0.38 mm	0.25 mm
	6.0-9.0		0.30 mm
PE	<2.5	$0.07\ D_6$[1] + 0.3 mm	$0.9\ s_4 - 0.1$ mm
PVC	≥2.5	$0.07\ D_6$[1] + 0.5 mm	

[1] Cables without screen: to be replaced by outer diameter of outer conductor D_3.

5.8 *Weight calculation*

The approximate total weight of the cable is to be calculated from $m = \Sigma\, m_x$.

For the calculation of the individual weights, formulae are given in the following table:

Table 5.8

Solid inner conductor	$m_1 = \frac{\pi}{4} D_1^2 \cdot \gamma_1$	γ_1 according to table 3.2.1
Stranded inner conductor	$m_1 = \frac{\pi}{4} d_1^2 \cdot N_1\, k_{1r}\, \gamma_1$	k_{1r} according to table 3.3.1
Insulation	$m_2 = \frac{\pi}{4} (D_2^2 - D_1^2)\, \gamma_2$	γ_2 according to table 3.1 D_1 according to 5.3
Tubular outer conductor	$m_3 = \pi\, (D_2 + s_3)\, s_3\, \gamma_3$	γ_3 according to table 3.2.1
Braided outer conductor	$m_3 = \frac{\pi}{4} d_3^2\, N_3\, n_3\, k_{3r}\, \gamma_3$	k_{3r} according to table 3.3.2
Interposed medium between outer conductor and screen	$m_5 = \pi\, (D_3 + s_5)\, s_5\, \gamma_5$	γ_5 dependent on the material used D_3 according to table 5.4
Braided screen	$m_6 = \frac{\pi}{4} d_6^2\, N_6\, n_6\, k_{6r}\, \gamma_6$	γ_6 according to table 3.2.1 k_{6r} according to table 3.3.2
Sheath	$m_4 = \pi\, (D_6 + s_4)\, s_4\, \gamma_4$[1]	γ_4 according to table 3.1

[1] For cables without screen, D_6 is to be replaced by D_3.

6 Calculation of electrical properties

6.1 *D.C. resistance of conductors and screen, per unit length*

The values are to be calculated from the formulae in the following table:

Table 6.1

Solid inner conductor	$R_1 = \dfrac{4}{\pi D_1^2 \chi_1}$	χ_1, χ_3, χ_6 according to table 3.2.1 k_{1r} according to table 3.3.1 k_{3r} and k_{6r} according to table 3.3.2 d_3 and d_6 according to table 3.4
Stranded inner conductor	$R_1 = \dfrac{4 k_{1r}}{N_1 \pi d_1^2 \chi_1}$	
Tubular outer conductor	$R_3 = \dfrac{1}{\pi (D_2 + s_3) s_3 \chi_3}$	
Braided outer conductor	$R_3 = \dfrac{4 k_{3r}}{N_3 n_3 \pi d_3^2 \chi_3}$	
Braided screen	$R_6 = \dfrac{4 k_{6r}}{N_6 n_6 \pi d_6^2 \chi_6}$	

6.2 *Attenuation*

The total attenuation per unit length is to be calculated from:

$$\alpha = \alpha_1 + \alpha_2 + \alpha_3$$

where α_1, α_2 and α_3 are the attenuation components due to the inner conductor, dielectric and outer conductor. The attenuation is related to a cable temperature of 20°C. For temperatures $T \neq 20$°C, the attenuation α_T shall be calculated by:

$$\alpha_T = (\alpha_1 + \alpha_3)\sqrt{1 + 0.00393\,(T - 20\,°\mathrm{C})} + \alpha_2$$

NOTE — α_2 may be temperature dependent for some dielectric materials.

Formulae for calculation of α_1, α_2 and α_3 are given in the following table. These formulae are applicable for frequencies ≥10 MHz. Formulae for lower frequencies are under consideration.

Table 6.2

$\alpha_1 = \dfrac{4.58\, k_{1c}\, k_{1a}}{D_{1e} \ln D_{3e}/D_{1e}} \cdot \dfrac{\sqrt{\varepsilon_2 f}}{\chi_1}$ $\alpha_2 = 9.1 \sqrt{\varepsilon_2} \cdot \tan \delta_2 f$ $\alpha_3 = \dfrac{4.58\, k_{3c}\, k_{3a}}{D_{3e} \ln D_{3e}/D_{1e}} \cdot \dfrac{\sqrt{\varepsilon_2 f}}{\chi_3}$	χ_1 and χ_3, k_{1c} and k_{3c} according to tables 3.2.1 et 3.2.2 k_{1a} and k_{3a} according to table 3.5 ε_2 and tan δ_2 according to table 3.1 D_{1e} and D_{3e} according to Subclause 5.2 and table 5.1 or Subclause 5.4

6.3 *Nominal characteristic impedance z_0 and capacitance C_2 per unit length*

$$z_0 = \frac{60^{1)}}{\sqrt{\varepsilon_2}} \ln \frac{D_{3e}}{D_{1e}}$$

$$C_2 = \frac{\sqrt{\varepsilon_2}^{\,1)}}{3\, z_0} \cdot 10^4 \,(\mathrm{pF/m})$$

ε_2 according to table 3.1;

D_{3e} according to table 5.1 or to 5.4;

D_{1e} according to 5.2.

---

1) Rounded up from 59.96 and 2.9979 respectively.

6.4 *Calculation of power rating*

The power rating shall be calculated from the attenuation and the maximum permissible dissipation power for an ambient temperature of 40 °C.

The maximum permissible dissipation power per unit length (P_d) is dependent on the maximum permissible temperature T_1 of the inner conductor, given by the maximum permissible temperature of dielectric (see table 3.1).

The temperature rise of the inner conductor above that of the stagnant ambient air is:

$$T_1 - 40\,°C = \frac{P_d}{2\pi}\left\{\frac{\alpha_1 + \frac{1}{2}\alpha_2}{\alpha}\sigma_2 \ln\frac{D_2}{D_1} + \sigma_4 \ln\frac{D_4}{D_6}\right\} + \left(\frac{1\,000\,P_d}{\pi\, D_4\, k_4}\right)^{0.8}$$

σ_2 and σ_4 according to table 3.1;

k_4 according to figure 1, page 6 .

For cables without screen, D_6 is to be replaced by D_3.

The first term of the sum is the temperature rise of inner conductor above sheath surface ($T_1 - T_4$). The second term is the temperature rise of sheath above ambient air ($T_4 - T_a$).

A graphical solution of this equation is proposed.

Having found P_d, the maximum permissible input power is given by:

$$P_{40} = \frac{868.6\,P_d}{2.2\,\alpha_T} = \frac{395\,P_d}{\alpha_T}$$

α_T according to 6.2.

The maximum attenuation may be 10% above the nominal value. Because of the unknown temperature of the outer conductor, the calculation assumes equality with the temperature of the inner conductor. The resulting error is negligible.

For ambient temperatures $T_a \neq 40\,°C$, the power rating shall be calculated from P_{40} by the empirical formula:

$$P_T = P_{40} \cdot \left(\frac{T_1 - T_a}{T_1 - 40\,°C}\right) 1.14$$

6.5 *Permissible voltages*

6.5.1 *Test voltage, dielectric, U_t*

The maximum value of voltage gradient is to be found at the surface of the inner conductor. It is limited by the maximum permissible voltage gradient E_2 of the dielectric. Hence the test voltage U_{tc} (r.m.s. value) is to be calculated from the formula:

$$U_{tc} = \frac{E_2}{\sqrt{2}} \cdot \frac{D_1 \cdot k_2}{2} \ln\frac{D_{3e}}{D_{1e}}$$

E_2 according to table 3.1;

k_2 according to table 3.3.1;

D_1 according to 5.3:

D_{1e} according to 5.2;

D_{3e} according to table 5.1 or to 5.4.

The value of U_{tc} shall then be rounded to the nearest 0.2 kV for values below 5 kV and to the nearest

0.5 kV for values of 5 kV and more. The rounded test voltage is designated U_t. The rounded test voltage shall be applied for 2 min at a frequency of 40 Hz to 60 Hz.

6.5.2 *Discharge test voltage, dielectric, U_d*

The discharge test voltage U_d (r.m.s. value) is given by the formula $U_d = 0.5\ U_t$ except in the case for polytetrafluoroethylene.

$$U_d = 0.4\ U_t \text{ with a minimum of } 1 \text{ kV}$$

6.5.3 *Maximum permissible operating voltage, U_o*

The maximum permissible operating voltage U_o (r.m.s value) is derived from the test voltage U_t.

$$U_{oc} = 0.45\ U_t$$

as far as the maximum permissible input power P_{40} will not be exceeded. The condition

$$U_o \leq \sqrt{Z_o\ P_{40}} / 1\,000$$

has to be met in each case. The value of U_{oc} shall then be rounded to the nearest 0.2 kV for values below 5 kV and to the nearest 0.5 kV for values of 5 kV and more. The rounded maximum permissible operating voltage is designated U_o.

6.5.4 *Test voltage, sheath*

For PVC sheaths:

Table 6.5

Nominal thickness of the sheath (s_4)	Test voltage (kV r.m.s.)	
mm	Immersion test	Spark test
Up to and including 0.5	No test	No test
Over 0.5 up to and including 0.8	2	3
Over 0.8 up to and including 1.0	3	5
Over 1.0	5	8

6.6 *Insulation resistance*

$R_2 \geq 10.000$ MΩkm

7 Climatic and mechanical robustness

7.1 *Tests*

Table 7.1

Item	Details to be included in detail specification
Capacitance stability	High and low temperature[1] Maximum admissible variation of capacitance
Attenuation stability	High and low temperature[1] Test frequency Maximum admissible increase of attenuation (where applicable, preferably 0.3 dB/m and 1.5 dB/m at a frequency of 3 000 MHz)
Thermal stability	
Dimensional stability	Conditioning temperature: - for solid PE: 80(85) ±2 °C[2] - for other materials: [1] The permissible displacement between the end faces of inner conductor and dielectric is to be indicated
Flow test (For dielectric of solid PE, $1.5 < D_2 < 17.3$ only)	The minimal value of the applied force is given by the empirical expression: The calculated value is to be rounded up to the nearest 5 N
Stability to ultraviolet rays	Under consideration

[1] Temperatures shall preferably correspond to those of IEC Publication 68-2:
— Test A (−65, −55, −40, −25, −10 °C);
— Test B (+200, +155, +125, +100, +85, +70, +55, +40 °C).

[2] According to table 3.1, note 4.

7.2 *Operating data*

Table 7.2

Minimum bending radius	5 × D_4 for single indoor laying 10 × D_4 for single outdoor laying
Minimum coiling diameter	-
Minimum permissible laying temperature	−15 °C dielectric PE, sheath PVC quality 1 −40 °C dielectric PE, sheath PVC quality 2 −55 °C dielectric and sheath FEP and PTFE Cautious laying without shocks recommended